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ABSTRACT

An experiment explored the effect of group size on student learning when small groups of students worked together at a computer assisted instruction (CAI) terminal. Both learning effectiveness and efficiency were considered. Sixty college students were divided into three groups--19 students studying alone, 16 studying in pairs, and 15 studying in groups of 3 or 4. Students worked together at the PLATO IV CAI terminal and then completed criterion-based tests individually on the material covered and an attitude questionnaire. No significant differences in achievement were found, but very significant differences in the time to complete the module were observed. Pairs of students required the most time, and groups of 3 or 4 required the least time. When total achievement scores for the group were divided by the total time at the terminal, learning efficiency was found to increase with group size. It may be concluded, therefore, that learning effectiveness is not substantially altered by small group use of CAI terminals, but the relative efficiency is considerably improved. (DGC)

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INDIVIDUAL AND SMALL GROUP LEARNING WITH COMPUTER ASSISTED INSTRUCTION

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One teacher working with one student is an expensive venture whether the teacher is human or mechanical. The advantages of tutorial instruction may be considerable but the costs also may be prohibitive. Consequently, the need arises for identifying effective cost-efficient group teaching procedures. The purpose of this study was to examine the effects on achievement and attitudes of having varying numbers of students studying together at a computer terminal.

Background

The cost for computer assisted instruction (CAI) has been widely debated. In 1967, Business Week reported that a Los Angeles computer expert estimated that it would cost $500,000 to develop CAI programs for just two classes which would amount to approximately $400 per student contact hour. However, actual cost figures from successfully implemented CAI programs have been much more promising. The cost of a daily 12-minute session in schools located at an average distance of 10 miles from Stanford University was 40¢ per student. Based on a school year of 175 days, the yearly cost of the CAI reading program was $70 per student (Jamison, et al, 1972). Bitzer and Skarperdas (undated) estimate that PLATO IV will eventually achieve a cost of approximately 30¢ per student contact hour when using 4,000 terminals.

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For more efficient use of CAI, Fletcher and Atkinson (1972) suggest we are better off leaving some of the instruction to the teacher and incorporating the effective findings of computer-managed instruction (CMI). This would be a way to attack prohibitive computer costs by limiting the range of responsibility of the computer. Zinn and McClintlock (1970) also suggest the cost in preparation and use would sharply decrease if subject experts worked cooperatively on computer-based materials for similar courses or programs at cooperating institutions.

But costs are not the only concern for efficient instruction. If efficiency can be defined as the ratio of achievement to time, other considerations become viable--especially in the face of delayed realization of the promised low costs per student contact hour. Hence, one way to attack the problem of efficiency with computer instruction is to create instructional settings with multiple simultaneous users.

In a recent article about obstacles to CAI use, Anastasio (1974) suggests plans for future action to improve the quality and probability for wide-spread CAI adoption. One of his suggestions is for research to identify computer terminal features that might be particularly appropriate for educational applications. Although he does not specifically mention multiple simultaneous users, research on pedogogical, learning, and individual difference variables (such as social motivational skills) may be shown to positively affect learning with improved terminals and multiple users. If this can be shown, it will have significant implication for the design of terminals to accomodate more than one user at a time.

Having more than one user at a time poses interesting questions about the individualized nature of CAI. CAI is individualized in the sense that decisions and branching may be based on individual performance and on

pre-instructional variables such as learning style, motivation, learning pace, and ability. Will the quality of instruction based on these variables be affected with multiple users? Recently, Castlebury et al, (1974) noted a drop in costs per student contact hours on CAI. They report it is still as high as $2.07/hour. However, they foresee dividing this figure by 2 or as much as 4 by having multiple users at the same console as long as achievement is maintained at an acceptable level.

When considering the effectiveness of CAI in terms of achievement it is reasonable to postulate that some variables may be operating within small groups to facilitate or interfere with individual achievement. Obertino (1974) suggests (as do many proponents of individualized instruction) that different students learn in different ways (at their own pace, for example) and that students do not profit from public exposure of their mistakes and weaknesses. Some of these "principles" that possibly may affect group instruction at a computer terminal have been identified by Hilgard and Bower (1966). These are: active participation, reinforcement of correct responses, novelty, anxiety level, encouragement, and group atmosphere (competition vs. cooperation; authoritarianism vs. democracy; individual isolation vs. group identification). Since effective computer courseware relies on the application of psychological findings (Stolurow, 1974), attention to these variables is critical.

It is obvious that placing more than one student at a CAI terminal will reduce the cost per instructional hour. Whether this reduction is significant will depend upon the type of system being used and the purposes for its use. But it is not sufficient to declare cost reduction as justification for arranging more chairs in front of the terminal. It must first be determined if the instruction is still effective in terms of student achievement. That concern is the subject of this research.

Procedure

Sixty students enrolled in four undergraduate elementary methods were selected for the study and assigned at random to one of three treatment groups.* Approximately 90 percent of the students were females and nearly all were college juniors with no previous experience using CAI.

The three groups of students received instruction at a PLATO IV computer terminal complete with screen, keyboard, and microfiche capability. Students in the first group studied alone, those in the second group in pairs, and those in the third treatment in groups of three or four.** Each individual student, pair, trio, or quartet was scheduled for three hours of computer terminal time in two sessions. The individuals or groups were to use as much of the allotted time as they needed to complete the instruction.

All students studied a PLATO IV instructional module on Bloom's mastery learning strategy as one of the requirements for an elementary science methods course. The materials were designed to help students achieve 10 objectives associated with mastery learning. To accomplish this, students received information and frequent practice exercises with feedback related to the objectives. Minimum performance standards were set for most of the practice exercises which had to be reached before new material was introduced. If students failed to meet the standards they were automatically cycled back in the program to restudy pertinent material.

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*The complete study involved another group of 20 students using individualized paper and pencil materials. Only the portion of the study using CAI is described in this paper.

**It was originally intended for these to be groups of four but experimental attrition resulted in several groups of only three students.

A single set of answer responses was entered at the PLATO IV terminal whether students were studying alone or in groups. Group learners were told to select one person to be the keyboard operator at a time and to rotate the assignment so that each person in the group spent some time entering responses during each session.

Following their study of the mastery learning segment, all students completed a criterion test based on the 10 objectives of the CAI program. The questions on the test covered objectives on the steps in mastery learning, sources of objectives, writing and sequencing objectives, and preparing diagnostic tests. Students also completed a questionnaire designed to test their attitudes toward the content of the mastery materials. The attitude measure consisted of 22 statements related to tests, testing, CAI, and diagnostic teaching to which responses from strongly agree to strongly disagree could be made. The instrument had been used in a previous investigation in which the reliability was found to be 0.58.

Results

Mean scores and standard deviations for achievement in the cognitive criterion test, the attitude questionnaire, and the study time for each of the three groups are shown in Table 1. The results of analyzing these data using One-way ANOVA are also given.

No significant differences among the three groups in either cognitive achievement or attitude toward the content of the CAI materials was noted. There were, however, highly significant differences in study time. Pairs of students used the most time to study ($\bar{X}$ = 125.8 minutes), students working alone used less time than pairs ($\bar{X}$ = 109.4 minutes), and groups of three or four students used the least amount of time ($\bar{X}$ = 86.3 minutes).

TABLE 1

Results of Students Using CAI Under Three Treatment Conditions

Dependent Measures		Studying Alone n = 19[a]	Studying in Pairs n = 16	Studying in groups of 3 or 4 n = 15	F-ratio
Cognitive Test[b]	$\bar{X}$	71.47	68.12	67.80	0.67
	S.D.	7.34	11.35	9.47	
Study Time (minutes)	$\bar{X}$	109.37	125.80	86.27	17.78*
	S.D.	18.22	27.90	11.44	
Attitude Questionnaire[c]	$\bar{X}$	88.00	83.75	84.00	1.73
	S.D.	6.03	7.76	8.07	

*$p < .01$

[a]the original 60 subjects were modified to the numbers shown because they either failed to complete the instruction or the post treatment measures.

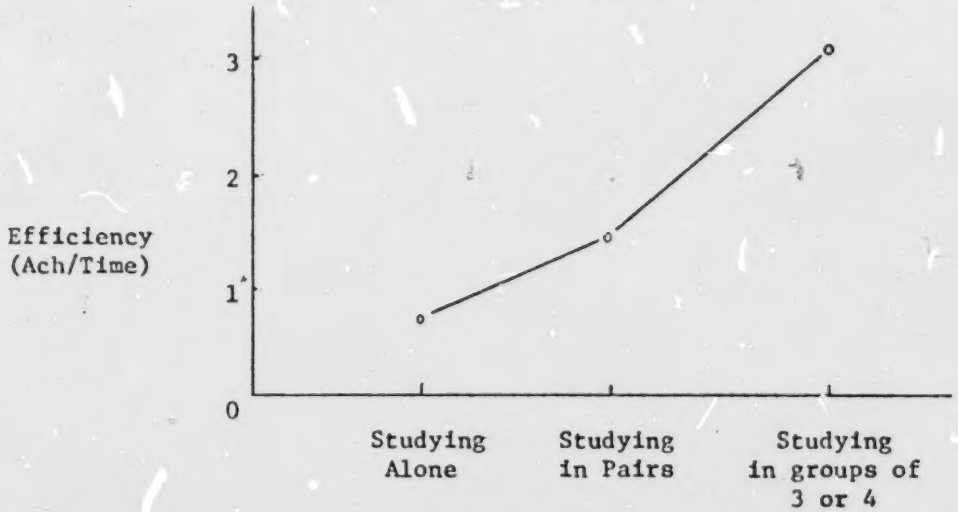
[b]the maximum score on the test was 100.

[c]scores on the attitude questionnaire could range from 22 to 110.

The relative efficiency of the three study groups is shown in Figure 1. Efficiency was calculated by dividing the weighted mean achievement score for each group by their mean study time. Thus groups studying in pairs had the numerator of the achievement/time ratio doubled and groups of three or four had the numerator multiplied by three or four as appropriate.

FIGURE 1

Relative Efficiency of Students Using CAI



Discussion

It would appear from the data in this study that learning can take place equally effectively and more efficiently with multiple users. Having three or four students sit in front of one terminal, without any modifications of the hardware, did not cause differences in achievement on the posttest. Hence, costs per student contact hour can be cut by a factor of three or four. Further, the data suggest that this increased efficiency does not effect the attitudes of the students toward the materials and the learning situation.

From an efficiency standpoint, a strong case can be made for groups studying at a single terminal. Not only was achievement of individual students the same as single users but the students acquired the information more quickly. Students working alone acquired the information in about an hour and forty-five minutes, students in groups of three or four learned the same amount in less than an hour and one-half. This savings of

approximately 20 minutes could lead to a significant reduction in costs by itself. But when one considers that up to four students were processed simultaneously during the shorter learning time, the savings appear even more significant.

These conclusions lead to questions that were not directly assessed. In addition to formal measures of achievement, time, and attitude, a number of informal observations were obtained from the proctors present at all training sessions. They reported occasional problems of incompatability, domination of a group by a strong leader, and some reluctance to participate when three or four persons attempted to study together. To some degree these problems occurred with all of the groups but primarily with the larger ones. A more frequent observation by the proctors was that harmonious and constructive discussion occurred frequently among pairs of students studying together. The fact that this happened is reflected in their significantly higher study time.

The conclusions of this research are somewhat limited by the kind of subject matter, the relatively short duration of the experiment and the specific conditions under which it was conducted. It would be interesting to note the effects of long-term retention between these groups. And, further investigation of the ability of the mastery posttest to discriminate among any groups would be appropriate.

These limitations notwithstanding, the major finding of the study seems to indicate that as many as four students may use the CAI terminal simultaneously and learn as much as students working alone. If this finding holds in other studies, this increased efficiency may provide a means to significantly decrease computer costs per student contact hour.

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